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The Socioeconomic Determinants of Crime in Ireland from 2003-2012

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Abstract: This paper analyses the socioeconomic determinants of property crime and violent crime in Ireland between 2003 and 2012. The aim of the study is to determine whether individuals respond to incentives when deciding to engage in crime and whether this decision is dependent on the type of crime an individual engages in. The results of the paper support the economic theory of crime which indicates that criminals respond to incentives, particularly for property crimes. Higher detection rates have been found to reduce crime rates for property crimes while the impact on violent crimes is found to be insignificant. The socioeconomic determinants of crime tend to be more ambiguous.

I INTRODUCTION

This paper analyses the socioeconomic determinants of both property and violent crimes in Ireland between 2003 and 2012. The aim of the study is to determine whether individuals respond to incentives when deciding to engage in criminal activities and whether this decision is dependent on the classification of crime. The CSO Annual Crime Statistics provide data for six Garda regions, which comprise of 28 Garda divisions. However, socioeconomic data sourced from the CSO are only available at a county level and therefore Garda divisional data have been aggregated to the county level. This provides this paper with a unique dataset to estimate the impact of the determinants of crime in Ireland.

The seminal work of Becker (1968) and Ehrlich (1973) led to a wave of empirical work examining the socioeconomic determinants of crime. Becker stressed that "crime is an economically important activity or 'industry'... almost

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total neglected by economists" (1968, p. 170). Since then, many studies have investigated whether individuals respond to incentives to engage in criminal activities. Incentives can be classified as both 'carrot' and 'stick'. For example, more opportunities in the illegal labour market may induce individuals to leave the labour market in favour of criminal activities whereas higher apprehension rates and longer incarceration rates may dissuade individuals from engaging in criminal activities.

Much of the research on the economics of crime has been conducted in the United States (Becker, 1968; Ehrlich, 1973; Freeman, 1982; Chiricos, 1987; Grogger, 1998; Levitt, 1998; 1999; 2001) with further studies emerging in the UK (Wolpin, 1978; Witt *et al*., 1998; 1999; Carmichael and Ward, 2000; 2001; Machin and Meghir, 2004; Han *et al.,* 2013), but as yet studies in Ireland have been scarce. Denny *et al*. (2004) estimate the determinants of burglaries in Ireland between 1952 and 1998. They find that while imprisonment and detection act as powerful forces for reducing crimes, they were unable to find any robust effect from direct measures of labour market activity such as unemployment rates or wage levels. More recently, Hargaden (2016) estimates the impact of an increase in the number of people on the Live Register on crime rates. The findings indicate increases in unemployment lead to an increase in crime, although the impact is more evident in property crimes as opposed to violent crimes.

This paper offers significant contributions compared to previous studies carried out in Ireland. Firstly, to the best of the author's knowledge this paper is the first which attempts to test the theoretical model of crime outlined by Becker (1968) across different categories of crime using economic, social and law enforcement variables in Ireland. Secondly, previous studies in Ireland fail to incorporate the dynamics of crime into their analysis. This paper includes lagged crime rate as an explanatory variable to capture crime dynamics. Thirdly, the inclusion of lagged endogenous variable as an explanatory variable requires the adoption of an instrumental variable estimation by using a Generalised Method of Moments (GMM) estimation. Most work in the area has used times series analysis and OLS methods so this paper offers advantages in methodology. Much of this work is hampered by endogeneity issues as a result of the reverse causation between crime rates and deterrence variables. This paper controls for endogeneity employing an instrumental variable approach for panel data. Finally, the time period included in this study is significant for Ireland as a result of the emergence of the financial crisis which deeply impacted the Irish economy. In this vein Kelly (2009) warned that

> *Ireland is at the start of an enormous, unplanned social experiment on how rising unemployment affects crime, domestic violence, drug abuse, suicide, and a litany of other social pathologies.*

The rest of the paper is structured as follows; Section II outlines a review of the previous literature in the area, Section III highlights the data used for this study while Section IV outlines the methodology and model specification. Section V shows the results of the estimations and Section VI concludes the article.

II SOCIOECONOMIC DETERMINANTS OF CRIME – THEORY TO EMPIRICS

Becker (1968) provided a model in which individuals optimally choose whether or not they will commit crimes. Under Becker's model of crime, individuals rationally analyse the costs and benefits of engaging in crimes. Benefits include the financial reward for engaging in crime as well as potential psychological benefits of crime. Furthermore, decisions are influenced by the probability of being caught, the severity of punishment and the opportunity cost in terms of other activity forgone e.g. employment in the legal labour market.

Attitudes towards risk are central to economic models of criminal choice. For example, risk averse individuals will respond more to changes in the chance of being apprehended than to changes in the extent of punishment, other things being equal. An empirical test of Becker's model involves testing whether people do actually respond to changes in such costs and benefits (Han *et al*., 2013). However, opportunity costs seem to be absent from the model. Ehrlich (1973) addressed this issue by developing a model which allows individuals allocate their time freely between legal and illegal labour markets. Furthermore, Ehrlich analysed additional socioeconomic determinants of crime such as an individual's level of income and unemployment rates. His aim, however, is still maximising the expected utility. The rest of this section highlights the empirical tests of various economic, social and law enforcement variables on crime.

Deterrence is an important subject not least because it lowers crime rates but furthermore, in comparison to incapacitation, it is relatively cheap. Researchers have used a variety of deterrence variables to examine the determinants of crime including detection rates (Denny *et al*., 2004; Han *et al*., 2010; Bandyopadhyay *et al*., 2011), clear up rates (Wolpin, 1978; Edmark, 2005), and number of police (Levitt, 1998; Bun, 2015; Chalfin and McCrary, 2017). These studies have generally found crime deterrence variables to reduce crime rates, particularly for property crimes.

Many studies have focused on the relationship between crime and employment. Early reviews (Freeman, 1982; Chiricos, 1987) suggest unemployment has positive impact on crime, but the magnitude of this effect is small and results are inconsistent across studies. Chiricos (1987) finds that unemployment has a statistically significant positive effect on property crime in 40 per cent of the studies, while the effect on violence gives a statistically significant positive result in only 22 per cent

of studies. The notion that unemployment encourages criminal behaviour as a result of increasing incentives is appealing and grounded in the notion that people respond to incentives. However, results of studies estimating the impact of unemployment on crime tend to be ambiguous in nature and robustness. One explanation for the lack of consensus in estimation results is that many people who engage in crime are also part of the legitimate labour force. Hertzman (1993) and Freeman (1999) document how the majority of those who participate in the illegal sector simultaneously derive income from legitimate jobs.

Results indicate that unemployment has a greater impact on crimes against property rather than crimes against the person. Edmark (2005) studies the relationship between unemployment and crime in Sweden between 1988 and 1999, a particularly volatile period in the labour market. The results show that unemployment had a positive and significant effect on some property crimes. Bandyopadhyay *et al*. (2011) examine the impact of unemployment on six different crime types across 43 police force areas in the United Kingdom using quantile analysis. The results indicate that not only does unemployment increase crime but it does so more in high crime areas. Moreover, they find that the crime-reducing effect of higher detection rates is stronger in low-crime areas. Also, Entorf and Sieger (2014) estimate the impact of unemployment on crime in Germany, finding that while both conventional OLS and quantile regressions confirm the positive link between unemployment and crime for property crimes, results for assault differ with respect to the method of estimation. Studies examining the impacts of unemployment on crime in Ireland tend to be scarce. Recently, Hargaden (2016) examines the relationship between crime and the labour market in Ireland between 2003 and 2014. Using Ordinary Least Squares (OLS), first differences (FD) and instrumental variable (IV) techniques, Hargaden (2016) estimates property crime elasticity of about 0.5. This implies that a 10 per cent rise in numbers on the Live Register increases thefts and burglaries by 5 per cent. As expected, there is a much weaker connection between the labour market and violent crime.

Ehrlich (1973) proposes the mean family income should be taken as proxy for illegal income opportunities. He argues that a higher income level means higher transferable assets and thus more lucrative targets for potential criminals. Contrastingly, other studies have used mean income as a proxy for legal income opportunities with higher income associated with more rewarding legal jobs. As such, ambiguity exists when interpreting the results of the impact of income on different types of crime. Gould *et al*. (2002) notes that both wages and unemployment are significantly related to crime, but that wages played a larger role in the crime trends over the last few decades.

Baharom and Habibullah (2008) study the relationship between income, unemployment and crime in 11 European countries using panel data analysis between 1993 and 2001 for both aggregated (total crime) and disaggregated (subcategories) crime. Their results show that both income and unemployment have

an important relationship with both aggregated and disaggregated crime. Crime displays a positive significant relationship with income per capita for all the categories except for domestic burglary. Entorf and Spengler (2000, p.85) suggest a relative income measure may be more straightforward to interpret. The authors highlight a measure of relative income which measures the percentage distance between the income of individual states and the mean income of all states and note that:

> *a higher income inequality, for instance, may lead to worse legal income opportunities and, at the same time, to better illegal income opportunities for the lower quantiles of the income distribution.*

Young male persons as a percentage of the population are included in many studies estimating the effects of deterrence on crime as they are considered the most likely socio-demographic age group to engage in criminal activities. Grogger (1998, p. 756) notes:

> *Thirty five per cent of all Philadelphia males born in 1945 were arrested before the age of 18, and one-third of all Californian men born in 1956 were arrested between the ages of 18 and 30.*

Narayan and Smyth (2004), in their study on Australia, examine the relationship between seven different categories of property crime and violent crime against the person, male youth unemployment and real male average weekly earnings between 1964 and 2001. The findings indicate that fraud, homicide and motor vehicle theft are cointegrated with male youth unemployment and real male average weekly earnings. However, there is no evidence of a long-run relationship between either breaking and entering, robbery, serious assault or stealing with male youth unemployment and real male average weekly earnings. Denny *et al*. (2004) explain the evolution of the trend in burglary in Ireland in terms of demographic factors: in this case the share of young males in the population, the macro-economy in the form of consumer expenditure and two characteristics of the criminal justice system; the detection rate for these crimes and the size of the prison population. The share of young males is associated with higher levels of these crimes. However, the authors were unable to find any robust effect from direct measures of labour market activity such as unemployment rates or wage levels.

III DATA

This paper uses Irish crime data sourced from the Central Statistics Office (CSO). CSO provides a detailed set of crime categories based on administrative data provided by An Garda Síochána from their PULSE system. The crime categories

are based on the Irish Crime Classification System (ICCS). The CSO Annual Crime Statistics provide data for six Garda regions, which comprise of 28 Garda divisions. Data at Garda division level are very detailed and relate to specific crime categories; however they are only available at a broad spatial scale. For the majority of counties the county boundaries are used as boundaries for Garda divisions, however for certain counties Garda divisions differ. Larger counties are broken down into smaller divisions, for example Dublin is broken down into five Garda divisions - DMR Eastern, DMR North Central, Northern DMR, South Central DMR, Southern DMR and Western DMR; while Cork County is broken down into three Garda divisions - Cork City, Cork North and Cork West. For the purposes of this paper, Garda divisions in Cork and Dublin are aggregated to county level as socioeconomic variables are only available at this level of aggregation and thus it makes more sense for empirical testing to carry out analysis at this level of aggregation. Smaller counties are aggregated into a single Garda division, for example Laois and Offaly make up a single Garda division. As such, socioeconomic variables for these divisions are given by the average of the two counties e.g. unemployment for Laois/Offaly is given by the average of the unemployment rate across both counties.

The limitations of crime data in Ireland should be considered before attempting to analyse criminal activities. Firstly, the recorded counts of crime events often represent an underestimation of actual crime counts. The reasoning for this is that some crimes tend not to be reported to police, while counting and recording rules typically record only the most serious offence in any complex criminal transaction. Furthermore, evidence suggests that differences exist between reported crimes and recorded crimes in Ireland. CSO (2015) estimated that 20 per cent of crime reported to An Garda Síochána in 2011 via their Command Aided Dispatch (CAD) equipped divisions does not appear to be captured on the PULSE system. These CAD divisions accounted for approximately half of all recorded crime in Ireland.

Secondly, actual crime data may be incorrectly categorised or re-categorised which may distort the findings of particular concentration studies. In Ireland, an estimated 3 per cent of incidents were incorrectly classified to the wrong crime category while a further 4 per cent of cases had insufficient information to determine the correct classification. Some 7 per cent of incidents classified to Attention and Complaints (a non-crime category on PULSE) should have been classified as a crime, generally as either fraud or assault. The equivalent figures for Property Lost and non-crime Domestic Disputes were 4 per cent and 7 per cent respectively (CSO, 2015).

Thirdly, timing issues with recording crimes have been identified as a potential drawback to using crime data for analytical purposes. The length of time between reporting a crime and the recording of the crime on the PULSE system could be

associated with data errors such as the accidental exclusion of crime data and misspecifications of crime data. The CSO (2015) analysed all criminal offences created on PULSE in 2012, or 269,194 records, and found that 6.7 per cent of offences were created more than one week after the reported date.

Finally, evidence suggests crime data in Ireland are often incorrectly labelled detected or invalidated. The crime detection rate is often used as a measure of the ability of police to solve crimes, or as a general indicator of police performance (Smit *et al*., 2004). The CSO (2015, p.24) found that 35 per cent of the offences without a charge or summons sheet attached were incorrectly designated as detected, based on current Garda detection rules. This has the effect of reducing the overall number of detected crimes from 138,807 to approximately 116,500 cases or a drop of 16 per cent. Furthermore, the CSO concluded that 23.1 per cent of invalidated incidents were invalidated incorrectly.

Descriptive statistics for the various crime types, averaged over the 2003-2012 period, are reported in Table 1a and b.

Table 1a: Descriptive Statistics for Dependent Variables between 2003 and 2012

	No. of Obs.	*Mean*	*St. Dev*
Theft	210	1,885.24	1,051.82
Burglary	210	520.65	210.27
Fraud	210	87.02	38.12
Assault	210	330.86	76.45
Sexual Offences	210	38.50	15.24

Source: Author's analysis based on CSO data.

Table 1b: Descriptive Statistics for Independent Variables between 2003 and 2012

	No. of Obs.	*Mean*	*St. Dev*
Theft Detection Rate	209	21.51	7.39
Burglary Detection Rate	209	23.37	7.38
Fraud Detection Rate	209	57.31	15.05
Assault Detection Rate	209	68.88	9.57
Sexual Offences Detection Rate	209	59.54	14.93
Income	210	24,577	5,385
Relative Income	210	93.86	9.17
Unemployment Ratio	210	6.87	3.27
Male 15-24	210	7.49	6.50

Source: Author's analysis based on CSO data.

Table 1a shows the descriptive statistics for crime rates in Ireland between 2003 and 2012. Property crimes are more common than violent crimes. Theft is the highest recorded crime with 1,885 incidents per 100,00 people while sexual offences is the lowest with 41 recorded cases per 100,000. Table 1b shows that the likelihood of detection is much higher for violent crimes rather than property crimes. Both assault (68.88 per cent) and sexual offences (59.54 per cent) display detection rates much greater than those of theft (21.51 per cent) and burglaries (23.37 per cent). It should be noted that the number of observations for detection rates across crime categories is 209 (as opposed to 210 observations for the rest of the variables) as no crime detection rate figures were available for Sligo/Leitrim for 2012. Moving on, this paper will give a brief overview of the variables included in the study, the expected relationship of each variable with crime rates and data issues.

Deterrence: The detection rate of crime is used in this paper as a proxy for deterrence to engage in criminal activities. The detection (or clear up) rate is often used as a measure of the ability of police to solve crimes, or even as a general indicator of police performance. Higher detection rates are generally associated with lower levels of crime as higher probabilities of conviction leads to a reduction in the expected utility of crime. The CSO provide detection rates across a range of crimes in Ireland at Garda divisional level between 2003 and 2012. Garda divisional detection rates are aggregated up to county level.

Income: Income has been used as a measure of both legal and illegal activities in crime studies. Higher levels of income are associated with higher rewards for criminals due to increased opportunities of lucrative targets. Contrastingly, higher levels of income have also been estimated to reduce crime due to more opportunities to earn a living through legal activities. These interpretations have led to contrasting results for the estimated impact of income on crime levels. Total income per person is used as a measure of income in this study and is provided by the CSO at county and NUTS 3 regional levels.

Relative Income: Relative income is measured as the average income per person in a region relative to the national average. As such, this variable is a proxy for regional inequalities in income. The CSO provides income data for each county across the time period and thus allows for the calculation of relative income across regions.

Unemployment Ratio: The unemployment ratio is measured by the percentage of working age people on the Live Register in Ireland. The CSO provides data for the number of persons on the Live Register in Ireland between 2003 and 2012. The unemployment figure for a given year is taken as the number of people on the Live Register in the final month of the year. The unemployment ratio is calculated by dividing the unemployment figure by population at county level.

Male 15-24: The male population aged between 15 and 24 is included in the study as a sociodemographic estimate of crime. Studies have shown that this demographic is the most likely to engage in particular crimes. The paper uses data

from the Census 2002, 2006 and 2011 to estimate young male population by Garda division in Ireland. The Census provides population data broken down by age group and gender and annual data are estimated using annual average growth rates between the Census years.

IV METHODOLOGY

Framework of this research is based on the Becker-Ehrlich deterrence hypothesis. Notably, there are other factors which affect committing crimes, and they are included as explanatory variables in the specification of model. Crimes are classified as crimes against property (property crimes) and crimes against the person (violent crimes); both are assessed empirically by econometrics techniques. The empirical analyses on the effect of labour market opportunities on crime relies typically on four types of data (Freeman, 1995); aggregate time series data, cross-section data, regional panel data and individual level data. Analyses of the first two types confirm the existence of a positive relationship between unemployment and crime. These studies, even presenting some advantages, are very likely to be affected by biases due to the omission of relevant variables. This paper uses a Generalised Method of Moments (GMM) estimation as outlined by Arellano and Bond (1991) which presents significant advantages over alternative methods used in previous studies. Much of this work is hampered by endogeneity issues as a result of the reverse causation between crime rates and deterrence variables. This paper controls for endogeneity employing an instrumental variable approach for panel data. Furthermore, the GMM approach controls for unobserved region-specific effects and the existence of measurement errors afflicting in particular the crime data.

Studies examining the socioeconomic determinants of crime have highlighted many potential issues regarding econometric specifications. Firstly, when using panel data OLS estimates are biased when unobserved region-specific effects are statistically significant and in the case that regressors and these effects are correlated. Secondly, it is common in studies examining the relationship between deterrence and crime to include lagged dependent variables as a predictor of crime in the current period. The inclusion of lagged dependent variables allows for us to capture crime dynamics over time. OLS estimators result in inconsistent estimates since lagged crime rates and unobserved region-specific factors are necessarily correlated, even if the idiosyncratic component of the error term is serially uncorrelated. Buonanno and Montolio (2008) note:

> *An obvious solution to these problems is to eliminate the term i by taking first differences. However, OLS still does not consistently estimate the parameters of interest because first-differencing introduces correlation between the lagged dependent variable and differenced error terms.*

Thirdly, the explanatory variables included in crime studies are rarely strictly exogenous with a two-way relationship evident between crime rates and their determinants. Fourthly, crime data may be hampered by measurement errors discussed in the previous section which may induce biases in estimates.

These issues must be considered before carrying out an econometric analysis of socioeconomic determinants of crime and the GMM estimator was chosen as it offers considerable advantages over other approaches. The GMM technique allows us to control for endogeneity by using the instrumental variables. Following Bun (2015), this paper utilises internal instrumental variables which exploits lagged values of endogenous variables as instruments. Bun (2015, p. 205) notes that while use of internal instruments is relatively scarce in empirical crime studies, they greatly enhance the precision of the deterrence estimates. Utilising internal instruments as opposed to external instruments overcomes a persistent issue found in the literature on deterrence and crime, namely the difficulties in identifying external instruments which are exogenous. Bun (2015) shows internal instruments are a viable alternative to external instruments once serial correlation is not present in the idiosyncratic errors.

To check the validity of the estimated specification, this paper reports the p-value of Hansen's (1982) J test of over-identifying restrictions and the p-value of Arellano and Bond's (1991) test of serial correlation of the disturbances up to second order. The Sargan-Hansen J test is used to determine empirically the validity of the over-identifying restrictions in the GMM model while the p-value of Arellano and Bond's (1991) test of serial correlation is used to test the validity of lagged instruments and crucially depends on the absence of higher-order residual autocorrelation in the first differences model.

Model Specification

$$Crime_{i,t} = \alpha + \beta Crime_{i,t-1} + \beta Detection_{i,t} + \beta Income_{i,t} + \beta Rel.income_{i,t} + \beta Unemp_{i,t} + \beta male16\text{–}24_{i,t} + \varepsilon_{i,t}$$

with $i = 1...N$ denoting regions, and $t = 1...T$, denoting time periods.

$\text{Crime}_{i,t}$ = Crime rate per 100,000
$\text{Crime}_{i,t-1}$ = Lag of Crime rate per 100,000
$\text{Detection}_{i,t}$ = Detection rate
$\text{Income}_{i,t}$ = Average Income per person in region
$\text{Rel.Income}_{i,t}$ = Average Income per person in region/Average Income per person nationally
$\text{Unemp}_{i,t}$ = Unemployment ratio
$\text{male16–24}_{i,t}$ = Percentage of males in population between ages 16-24

In the above specification, α and β are parameters to be estimated. α is time invariant and control for region-specific effects is not explicitly included in the regression equation. Lagged crime rate measures the persistence of crime over time. Han *et al*. (2013) note there could be several reasons why crime rate can be thought to be correlated over time: (1) recidivism caused by, among other things, negative expected payoffs from the labour market for being a criminal; (2) business cycle features such as recessions affecting the crime rate over successive periods and (3) peer effects with lagged crime acting as a proxy for fluctuating peer effects.

V ESTIMATION AND RESULTS

This section presents the results of the estimation of the models outlined in Section IV. The section analyses whether crime detection rates act as a deterrence for individuals engaging in criminal activities in Ireland as well as interpreting the impact of socioeconomic factors on crime in Ireland between 2003 and 2012. The paper is concerned with estimating the socioeconomic determinants of crime in Ireland and as such a number of hypotheses have been developed in order to estimate the impact of these factors on crime.

Table 2 presents the results of the estimation of the socioeconomic determinants of crimes against property in Ireland between 2003 and 2012. All three crimes against property display a negative coefficient on detection rates which indicates that higher detection rates of crime lead to a statistically significant reduction in individuals engaging in criminal activity. A 10 per cent increase in detection rates is estimated to reduce theft rates by 2.45 per cent, burglary rates by 1.4 per cent and fraud rates by 6.1 per cent. These results are consistent with previous research in the area (Han *et al*., 2013).

The J-statistic is computed for the Sargan-Hansen over-identifying restrictions. Under the null hypothesis that the over-identifying restrictions are valid, the J-statistic follows a Chi-Squared distribution with the degree of freedom being the difference between the instrument rank and the number of coefficients estimated. The reported over-identification test is the corresponding *p*-value; non-rejection of the Sargan-Hansen test indicates validity of the instrument.

Crime rates in the previous period are estimated to have a positive and significant impact on crime in the current period across all categories of property crime. This indicates that crime may have an evolutionary element, with regions displaying high levels of crime continuing to record high levels of crime in subsequent periods. A ten-unit increase in number of crimes per 100,000 in the previous year is estimated to increase theft by 3.8 per cent, burglary by 2.8 per cent and fraud by 1.57 per cent. The results indicate that criminals engaging in activities involving crime against property respond to crime reduction incentives i.e. higher rates of detection. Also, regions with high levels of property crime in the previous

Table 2: GMM Estimation of Crimes against Property in Ireland between 2003 and 2012

Variable	*Theft*	*Burglary*	*Fraud*
Crime $t-1$	0.387	0.280	0.157
	(0.063)***	(0.096)***	(0.092)*
Detection Rate	–0.245	–0.140	–0.614
	(0.085)***	(0.074)***	(0.118)***
Income	1.443	–0.115	0.725
	(0.264)***	(0.204)	(0.377)**
Relative Income	–1.121	–0.582	–1.450
	(0.085)**	(0.464)	(0.906)
Unemployment Ratio	–0.097	0.016	0.022
	(0.028)***	(0.026)	(0.048)
Male Population	–0.028	–0.014	–0.049
	(0.068)	(0.048)	(0.096)
Sargan-Hansen	74.74	76.78	66.68
p-value	0.27	0.21	0.52
No. of Observations	146	146	146

Source: Author's analysis based on CSO data.
Notes: *** Significant at 1% level; ** significant at 5% level; * significant at 10% level.

year tend to continue to record high rates of property crime which suggests self-reinforcing processes of crime, evidence of career criminals and knowledge spillovers within a region.

Turning attention to the socioeconomic determinants of property crime, income per capita is estimated to have both a positive and significant impact on crime rates in Ireland for both theft and fraud. The sign on the coefficient for burglaries is negative for income, however the results are insignificant. Entorf and Spengler (2000) note that the results of studies estimating the impact of income on crime rates tend to be ambiguous as higher levels of income can be considered to both promote and deter crime. Higher levels of income provide more legal opportunities while also providing more lucrative criminal activities. A one per cent increase in income per capita is estimated to increase theft rates by 1.44 per cent while fraud rates increase by 0.73 per cent.

Entorf and Spengler (2000) note relative income is much easier to interpret than the standard income measure. Relative income is estimated to have a positive impact on the crime rate for crimes against property in Ireland between 2003 and 2012. The coefficient on all three categories of crime is negative which indicates that an increase in a region's income relative to the national average will reduce crime rates for all crimes against property. However, the results are only statistically significant for theft rates. A one per cent increase in relative income leads to a reduction in thefts by 1.12 per cent.

Perhaps surprisingly, the unemployment ratio is estimated to have a positive effect on crime rates for theft. An increase in the unemployment ratio of 1 per cent is associated with a fall in the theft rate of 0.09 per cent, with results statistically significant. A negative coefficient for unemployment is found for burglary and fraud rates, however the results are not statistically significant. The relationship between unemployment and crime rates is found to ambiguous at best. Han *et al*. (2013) find an increase in unemployment leads to a decrease in burglary and fraud rates, while an inverse relationship is evident for theft rates. One possible explanation for this is the unemployment rate captures the net effect of two countervailing forces; while higher unemployment motivates potential offenders to commit crime by reducing the opportunity cost of crime, it also reduces the opportunities available for crime thus presenting different impacts across crimes.

The results differ to those of Hargaden (2016) who, in a study of Ireland, finds that a deterioration in the labour market is associated with higher crime rates, with a property crime elasticity of 0.5. This implies that a 10 per cent rise in numbers on the Live Register increases thefts and burglaries by 5 per cent. There could be several possible reasons for this difference. Firstly, differences in aggregate levels could contribute to differences in results. Also, Hargaden (2016) uses total number of crimes as the dependent variable and total number of people on Live Register as the independent variable, while this study uses crime rates per 100,000 population as the dependent variable and county unemployment ratio i.e. number of unemployed per working population in a county as the independent variable. Third, direct comparison of this study with Hargaden (2016) is further complicated by the fact that a different set of explanatory variables, different model specifications and a different estimation methodology are included compared to this study. The results indicate that the percentage of males between the ages of 15-24 in the population is insignificant on crime rates.

Table 3 presents the results of the estimation of the socioeconomic determinants of crimes against the person in Ireland between 2003 and 2012. Similar to previous literature (Han *et al*., 2013; Hargaden 2016), the results of the detection rate on crimes tend to be more ambiguous across crimes against the person compared to crimes against property.

Detection rates are estimated to have no significant effect on crimes against the person in Ireland between 2003 and 2012. One explanation for this is that detection may not reduce all crimes as there may be some 'type' criminals who would not respond to incentives. Crime rates in the previous period are found to have a positive impact on crime rates in the current period. The coefficient is positive for both assault rates and sexual offences rates however the results are only significant for assault rates. A one-unit increase in assaults per 100,000 in the previous period leads to an increase in assaults in current period of 0.46 per cent.

The estimates for the socioeconomic determinants of crimes against the person tend to be ambiguous. The coefficient on income is positive for assault rates while

Table 3: GMM Estimation of Crimes against Persons in Ireland between 2003 and 2012

Variable	*Assault*	*Sexual Offences*
Crime *t*-1	0.466	0.003
	(0.102)***	(0.127)
Detection Rate	0.026	–0.119
	(0.082)	(0.140)
Income	1.047	–4.096
	(0.165)***	(0.497)***
Relative Income	–1.08	2.519
	(0.349)***	(1.115)**
Unemployment Ratio	–0.034	0.106
	(0.022)	(0.053)**
Male population	–0.000	–0.174
	(0.036)	(0.120)
Sargan-Hansen	66.49	74.22
p-value	0.52	0.28
No. of Observations	146	146

Source: Author's analysis based on CSO data.
Notes: *** Significant at 1% level; ** significant at 5% level; * significant at 10% level.

it is negative for sexual offences. This indicates that an increase in income leads to an increase in assaults while it leads to a fall in sexual offences; both results are statistically significant. An inverse relationship is evident between income and relative income i.e. when income is positive, relative income is negative and vice versa. An increase in relative income is found to reduce the rate of crime for assault while it is estimated to increase the rate of crime for sexual offences.

Similarly, the results of the unemployment ratio are found to be ambiguous for crimes against the person. A one per cent increase in the unemployment ratio is estimated to increase the sexual offences rate by 0.11 per cent, while the results for the impact of the unemployment ratio on assault rates is not statistically significant. Similar to crimes against property, the percentage of males aged between 15 and 64 are estimated to be insignificant on crime rates across all categories of crime in Ireland between 2003 and 2012.

VI CONCLUSION

This paper contributes to the literature on how property and violent crime responds to social, economic and law enforcement conditions in Ireland. The results of the paper support the economic theory of crime outlined by Becker (1968) which indicates that criminals respond to incentives, particularly for property crimes.

Higher rates of crime detection are associated with a fall in crime rates across all property crimes. A dynamic GMM model with fixed effects has been estimated which eliminates any time-invariant unobservable differences between counties that jointly determines the crime rate and (any of) our explanatory variables. Additionally, the potentially endogenous law enforcement variable – detection rate – has been instrumented by using past lagged values of this variable. This addresses the concern of potential reverse causality for this variable which has hampered previous studies in the area.

The use of GMM allows for the inclusion of lagged endogenous variable as an explanatory variable. This paper finds that the lagged variable is statistically and economically significant across all crime types, with the exception of sexual offences. This indicates that regions with high levels of property crime in the previous year tend to continue to record high rates of property crime which may indicate self-reinforcing processes of crime, evidence of potential career criminals and knowledge spillovers within a region. In line with the literature in the area, higher detection rates have been found to reduce crime rates for property crimes while the impact on crimes against the person is insignificant. A 10 per cent increase in detection rates is estimated to reduce theft rates by 2.45 per cent, burglary rates by 1.4 per cent and fraud rates by 6.1 per cent.

The socioeconomic determinants of crime tend to be more ambiguous with the significance of each variable varying across different crime types. Socioeconomic factors have the greatest impact on theft rates. While increases in income per capita are found to increase theft rates, possibly as a result of more lucrative illegal opportunities, increases in both relative income and unemployment are found to reduce the theft rate. For crimes against the person, the income variables are found to be statistically significant, though have opposing effects on each crime type. Increases in income are found to increase the number of assaults while lowering the number of sexual offences.

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